Course Descriptions - Mathematics


MA 101 Introductory Calculus 5R-0L-2C F (5 weeks)
Covers approximately the first half of MA 111, including analytic geometry in the plane, vectors in the plane, algebraic and transcendental functions, limits and continuity, and an introduction to differentiation. Entering first-year students will enroll in MA 111 and transfer to MA 101 if continuation of MA 111 is not appropriate.

MA 102 Differential Calculus 5R-0L-3C W Pre: MA 101
Covers approximately the second half of MA 111, including continuity, the derivative, geometrical and physical applications of differentiation, and an introduction to integration and Fundamental Theorem of Calculus. Students who do not transfer to MA 101 in the fall quarter, but do not satisfactorily complete all of MA 111, may use their midterm grade in MA 111 for credit and grade in MA 101 and enter MA 102 at the beginning of the winter quarter.

MA 111 Calculus I 5R-0L-5C F
Calculus and analytic geometry in the plane, including vectors. Algebraic and transcendental functions. Differentiation, geometric and physical interpretations of the derivative. Introduction to integration and the Fundamental Theorem of Calculus.

MA 112 Calculus II 5R-0L-5C F, W, S Pre: MA 111 or 102

MA 113 Calculus III 5R-0L-5C F, W, S Pre: MA 112
Functions of several variables, partial derivatives, maxima and minima of functions of several variables, multiple integrals, and other coordinate systems. Applications of partial derivatives and multiple integrals. Vectors and parametric equations in three dimensions, line integrals.

MA 215 Discrete and Combinatorial Algebra I 4R-0L-4C F

MA 221 Differential Equations and Matrix Algebra I 4R-0L-4C F, W, S Pre: MA 113
Basic matrix algebra with emphasis on understanding systems of linear equations from algebraic and geometric viewpoints, including the least squares process and eigenvalues and eigenvectors. Review of first order differential equations including basic solution techniques and numerical methods. Second order linear, constant coefficient differential equations, including both the homogeneous and non-homogeneous cases. Introduction to complex arithmetic, as needed. Applications to problems in science and engineering.

MA 222 Differential Equations and Matrix Algebra II 4R-0L-4C F, W, S Pre: MA 221
Laplace transforms. Solving systems of first order linear differential equations by Laplace transforms and investigation of their solution structure determined by eigensystems. Phase portrait analysis and classification and stability of
critical points for linear and non-linear systems. Approximation of functions including Taylor series and Fourier series. Applications to problems in science and engineering.

MA 223 Engineering Statistics 1 4R-0L-4C F, W, S Pre: MA 112
This is an introductory course in statistical data analysis. Topics covered include descriptive statistics, introduction to simple probability concepts, and random variables (including their linear combinations and expectations). The Central Limit Theorem will be presented. Hypothesis testing and confidence intervals for one mean, one proportion, and one standard deviation/variance will be covered as well as hypothesis testing and confidence intervals for the difference of two means. An introduction to one factor analysis of variance and simple linear regression will be presented. A computer package will be used for statistical analysis and simulation. Experimental data from a variety of fields of interest to the science and engineering majors enrolled will also be used to illustrate statistical concepts and facilitate the development of the student’s statistical thinking.

MA 302 Boundary Value Problems 4R-0L-4C S Pre: MA 222
Boundary value problems posed by partial differential equations. Extensions to three-dimensional problems, irregular regions, and non-rectangular coordinate systems. Integral transforms, Fourier series, numerical techniques.

MA 305 Advanced Calculus 4R-0L-4C F Pre: MA 113
Calculus of functions of several variables. Topics include differentiation (divergence, gradient, curl) and integration (line and surface integrals). Green’s theorem, Stokes’s theorem, and the divergence theorem are also covered.

MA 306 Functions of a Real Variable 4R-0L-4C W Pre: MA 113
Calculus of functions of a single variable. A more careful development of the basic concepts of analysis, including sequences, limits, continuity, differentiability, integration, infinite series, power series, Taylor’s Theorem, and uniform convergence.

MA 307 Introduction to Topology 4R-0L-4C F Pre: MA 222 or consent of instructor
An introduction to some of the important ideas, problems, and applications of topology from an intuitive point of view. Topics may include, but are not restricted to, classification of surfaces, orientability, the Euler Characteristic, patterns and complexes, coloring theorems, graph embeddings, vector fields, and the fundamental group. Intended for non-majors as well as mathematics majors.

MA 310 Functions of a Complex Variable 4R-0L-4C S Pre: MA 113
Elementary properties of analytic functions including Cauchy’s theorem and its consequences, Laurent series, the Residue Theorem, and mapping properties of analytic functions.

MA 315 Discrete and Combinatorial Algebra II 4R-0L-4C W Pre: MA 215

MA 323 Geometric Modeling 4R-0L-4C W Pre: MA113
Covers some of the mathematical methods for describing physical or virtual objects in computer aided geometric design (CAGD) and computer graphics. Emphasizes methods for curve and surface modeling, and discusses both the underlying geometric concepts and the practical aspects of constructing geometric models of objects. Topics covered include Bezier curves, Hermite curves, B-splines, Bezier patches, subdivision surfaces. In discussing these, ideas from analytic geometry, differential geometry, affine geometry, combinatorial geometry, and projective geometry will be introduced.
MA 325 Fractals and Chaotic Dynamical Systems 4R-0L-4C S Pre: CS 220 and MA 222

MA 331 Mathematical Modeling 4R-0L-4C W Pre: MA 221 or consent of instructor
An introduction to techniques of mathematical modeling involved in the analysis of meaningful and practical problems arising in many disciplines including mathematical sciences, operations research, engineering, and the management and life sciences. Topics include creative and empirical model construction, model fitting, models requiring optimization, and modeling dynamic behavior. Student participation in significant individual and group projects will be emphasized.

MA 348 Continuous Optimization 4R-0L-4C S (2004) Pre: MA 222
Optimization of nonlinear functions of real variables: algorithms for univariate optimization; Golden section, parabolic interpolation, hybrid methods; Newton's Method and variations for multivariate functions; conjugate gradients and quasi-Newton methods; line search strategies; penalty functions for constrained optimization; modeling and applications of optimization.

MA 351-6 Problem Solving Seminar 1R-0L-1C F, W, S Pre: Consent of department head
An exposure to mathematical problems varying widely in both difficulty and content. Students will be expected to participate actively, not only in the solution process itself but also in the presentation of finished work, both orally and in writing. A student may earn a maximum of six credits in MA 351-6.

MA 371 Linear Algebra I 4R-0L-4C F, S Pre: MA 221 or consent of instructor

MA 373 Applied Linear Algebra for Engineers 4R-0L-4C F Pre: MA 221 or consent of instructor

MA 378 Number Theory 4R-0L-4C S Pre: Consent of instructor
Divisibility, congruences, prime numbers, factorization algorithms, RSA encryption, solutions of equations in integers, quadratic residues, reciprocity, generating functions, multiplicative and other important functions of elementary number theory. Mathematical conjecture and proof, mathematical induction.

MA 381 Introduction to Probability with Statistical Applications 4R-0L-4C F, S Pre: MA 113
Standard probability concepts and laws; standard statistical distributions (both discrete and continuous) to include binomial, geometric, Poisson, normal, and exponential; introduction to sums of random variables and the central limit theorem; introduction to statistical estimators.
MA 383 Engineering Statistics II 4R-0L-4C W Pre: MA 223 or MA 381 and permission of instructor
Hypothesis testing, confidence intervals, sample size determination, and power calculations for means and proportions; two factor analysis of variance (with and without interactions); analysis of several proportions; confidence and prediction intervals for estimated values using simple linear regression; Pearson (linear) correlation coefficient; introduction to multiple regression to include polynomial regression; review of fundamental prerequisite statistics will be included as necessary.

MA 385 Quality Methods 4R-0L-4C S Pre: MA 223 or MA 381 and consent of instructor (May be taken as CHE 385.)
Introduction to various aspects of statistical quality control and statistical process control to include the following topics: importance of variance reduction and probability concepts influencing product quality and reliability; development and application of control charts (P-charts, NP-charts, C-charts, U-charts, individual’s charts, moving range charts, X-bar and R as well as X-bar and S charts); process capability indices (their use and misuse); introduction to acceptance sampling. Other topics to be included as time allows: 6 sigma thinking, gauge reproducibility and repeatability, and total quality management with the philosophies of Deming, Juran, and Crosby. Review of fundamental prerequisite statistics will be included as necessary.

MA 415 Discrete and Combinatorial Algebra III 4R-0L-4C S Pre: MA 315
Permutation groups and Polya’s theory of enumeration. An introduction to graph theory. Applications in chemistry, electrical networks, and computer science.

MA 416 Algebraic Codes 4R-0L-4C S Pre: MA 315 or consent of instructor
Construction and theory of linear and non-linear error correcting codes. Generator matrices, parity check matrices, and the dual code. Cyclic codes, quadratic residue codes, BCH codes, Reed-Solomon codes, and derived codes. Weight enumeration and information rate of optimum codes.

MA 423 Topics in Geometry 4R-0L-4C S (2005) Pre: MA371 or MA373 or consent of instructor
An advanced course in geometry. Topics could include from projective geometry, computational geometry, differential geometry, Riemannian geometry, algebraic geometry, Euclidean geometry and non-Euclidean geometry.

MA 431 Calculus of Variations 4R-0L-4C Pre: MA 305
Euler-Lagrange and Hamiltonian equations, with possible applications in mechanics, electrostatics, optics, quantum mechanics and elasticity theory. An introduction to direct methods. Applications will be chosen in accordance with the interest of the students. Both classical and numerical methods have their place in this course.

MA 433 Numerical Analysis 4R-0L-4C Pre: MA 222
Root-finding, computational matrix algebra, nonlinear optimization, polynomial interpolation, splines, numerical integration, numerical solution of ordinary differential equations. Principles of error analysis and scientific computation. Selection of appropriate algorithms based on the numerical problem and on the software and hardware (such as parallel machines) available.

MA 434 Topics in Numerical Analysis 4R-0L-4C Pre: MA 433
An extension of the material presented in MA 433. Topics might include numerical eigenproblems, numerical solution of partial differential equations (finite differences, finite elements, spectral methods), sparse matrices, global optimization, approximation theory.
MA 436 Introduction to Partial Differential Equations 4R-0L-4C Pre: MA 305

MA 439 Mathematical Methods of Image Processing 4R-0L-4C Pre: MA 222
Mathematical formulation and development of methods used in image processing, especially compression. Vector space models of signals and images, one- and two-dimensional discrete Fourier transforms, the discrete cosine transform, and block transforms. Frequency domain, basis waveforms, and frequency domain representation of signals and images. Convolution and filtering. Filter banks, wavelets and the discrete wavelet transform. Application to Fourier based and wavelet based compression such as the JPEG compression standard. Compression concepts such as scalar quantization and measures of performance.

MA 444 Deterministic Models in Operations Research 4R-0L-4C W Pre: MA 221 or MA 371/373
Formulation of various deterministic problems as mathematical optimization models and the derivation of algorithms to solve them. Optimization models studied include linear programs, integer programs, and various network models. Emphasis on model formulation and algorithm development from the ground up.

MA 445 Stochastic Models in Operations Research 4R-0L-4C S Pre: MA 223 or MA 381
Introduction to stochastic mathematical models and techniques that aid in the decision-making process. Topics covered include a review of conditional probability, discrete and continuous Markov chains, Poisson processes, queueing theory (waiting line problems), and reliability.

An introduction to graph- and network-based optimization models, including spanning trees, network flow, and matching problems. Focus is on the development of both models for real-world applications and algorithms for their solution.

MA 450 Mathematics Seminar 1R-0L-1C F, W, S Pre: Consent of instructor
A student must attend at least 10 mathematics seminars or colloquia and present at one of the seminars, based on material mutually agreed upon by the instructor and the student. A successful presentation is required for a passing grade. As seminars may not be offered every week during the quarter a student may extend the course over more than one quarter, but it must be completed within two consecutive quarters. A student may take this course a maximum of four times.

MA 461 Topics in Topology 4R-0L-4C Pre: MA 307 or consent of instructor
Introduction to selected topics from point-set topology or algebraic topology from a rigorous point of view. Possible topics include metric spaces, general topological spaces, compactness, connectedness, separation axioms, compactification and metrization theorems, homotopy and homology, and covering spaces. Intended for mathematics majors planning to pursue graduate study in mathematics.

MA 466 Introduction to Functional Analysis 4R-0L-4C Pre: MA 306
An introduction to the theory of Banach spaces emphasizing properties of Hilbert spaces and linear operators. Special attention will be given to compact operators and integral equations.
MA 471 Linear Algebra II 4R-0L-4C W or S Pre: MA 371 or MA 373
Continuation of Linear Algebra I. Properties of Hermitian and positive definite matrices and factorization theorems (LU, QR, spectral theorem, SVD). Linear transformations and vector spaces.

Students study mathematical models by which to answer three questions: What is a computer? What limits exist on what problems computers can solve? What does it mean for a problem to be hard? Topics include models of computation (including Turing machines), undecidability (including the Halting Problem) and computational complexity (including NP-completeness). Same as CSSE 474.

MA 479 Cryptography 4R-0L-4C S Pre: CSSE220 and MA215
Introduction to basic ideas of modern cryptography with emphasis on mathematical background and practical implementation. Topics include: the history of cryptography and cryptanalysis, public and private key cryptography, digital signatures, and limitations of modern cryptography. Touches upon some of the societal issues of cryptography (same as CSSE 479)

MA 481 Introduction to Mathematical Statistics 4R-0L-4C W Pre MA381
An introduction to the mathematics of statistics. Topics include: central limit theorem, gamma, Weibull, Chi-squared and bivariate normal probability distributions, transformations of two or more random variables, estimation of parameters by maximum likelihood and the method of moments, hypothesis testing for means, proportions, and variances, Neyman Pearson Lemma, Bayesian inference, distribution of order statistics, and other topics as time allows. Applications and derivation of Student’s t and F distributions. Emphasis will be placed on computer simulations to illustrate theoretical results.

MA 482 Bioengineering Statistics 4R-0L-4C Pre: MA 223 or MA 381 and consent of instructor (cross listed with BE422)
Hypothesis testing and confidence intervals for two means, two proportions, and two variances. Introduction to analysis of variance to include one factor and two factors (with interaction) designs. Presentation of simple linear and multiple linear regression modeling; development of analysis of contingency table to include logistic regression. Presentation of Log odds ratio as well as several non-parametric techniques of hypothesis testing and construction of non-parametric confidence intervals and correlation coefficients. Review of fundamental prerequisite statistics will be included as necessary.

MA 485 Applied Regression Analysis and Introduction to Time Series 4R-0L-4C Pre: MA 223 or MA 381 and consent of instructor
Review of simple linear regression; confidence and prediction intervals for estimated values using simple linear regression; introduction to such concepts as model fit, misspecification, multi-collinearity, heterogeneous variances and transformation of both independent and dependent variables; introduction to multiple regression to include polynomial regression; use of dummy variables and diagnostics based on residuals; sequential variable selection to include forward inclusion and backward exclusion of variables; best subset regression; introduction to time series; autocorrelation; moving averages and exponential smoothing.

MA 487 Design of Experiments 4R-0L-4C Pre: MA 223 or MA 381 and consent of instructor
Review of one factor analysis of variance; tests for homogeneity of variance and model assumptions; multiple comparisons, post hoc comparisons, and orthogonal contrasts; two factor analysis of variance (with and without interactions); three factor and higher full factorial designs; analysis of covariance and repeated measures designs; screening designs to include 2 to the k and 3 to the k design; fractional factorial designs; introduction to General Linear Models. Other topics that may be included as time allows: fixed,
random, and mixed designs as well as nested designs. Review of fundamental prerequisite statistics will be included as necessary.

**MA 490 Topics in Mathematics Variable credit Pre: consent of instructor**

This course will cover advanced topics in mathematics not offered in listed courses.

**MA 495 Research Project in Mathematics Variable credit Pre: consent of instructor**

An undergraduate research project in mathematics or the application of mathematics to other areas. Students may work independently or in teams as determined by the instructor. Though the instructor will offer appropriate guidance in the conduct of the research, students will be expected to perform independent work and collaborative work if on a team. A satisfactory written report and oral presentation are required for a passing grade. The course may be taken more than once provided that the research or project is different.

**MA 534 Management Science 4R-0L-4C Pre: Senior or graduate standing**

A study of the development and analysis of various mathematical models useful in managerial decision-making. This includes discussions of what models are, how to create them, how they are used, and what insights they provide. Spreadsheets will be used to do much of the computational work. Topics considered include linear, integer, and nonlinear programming, network models, inventory management, project management, and simulation models. Examples from all areas of business and industry will be investigated. We will also investigate how companies are using these techniques to solve current problems. Crosslisted with MG534.

**MA 580 Topics in Advanced Probability Theory and Its Applications 4R-0L-4C Pre: MA 381**

Advanced topics in probability theory as well as applications that are not offered in the listed courses.

**MA 581 Topics in Advanced Statistics 4R-0L-4C Pre: MA 223 or MA 381 and consent of instructor**

This course will cover advanced topics in mathematical statistics as well as applied statistics that are not offered in the listed courses.

**MA 590 Graduate Topics in Mathematics Variable credit Pre: consent of instructor**

This course will cover graduate-level topics in mathematics not offered in listed courses.